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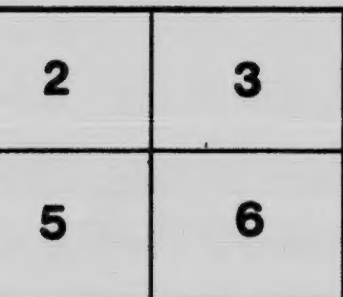
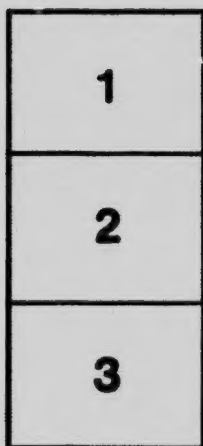
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ONTO

CHEMICAL

EFFECT OF "ACID PICKLE"
PARTIAL RESTORATION ON
AND W. R. LANG

CHEMICAL INDUSTRY, Vol. XXV.)



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THE DETERIORATING EFFECTS OF
"ACID PICKLE" ON STEELS
AND THEIR PARTIAL
REMEDY BY "BAKING."

BY
HERBERT A. BAKER AND W. F. BAKER

LONDON :
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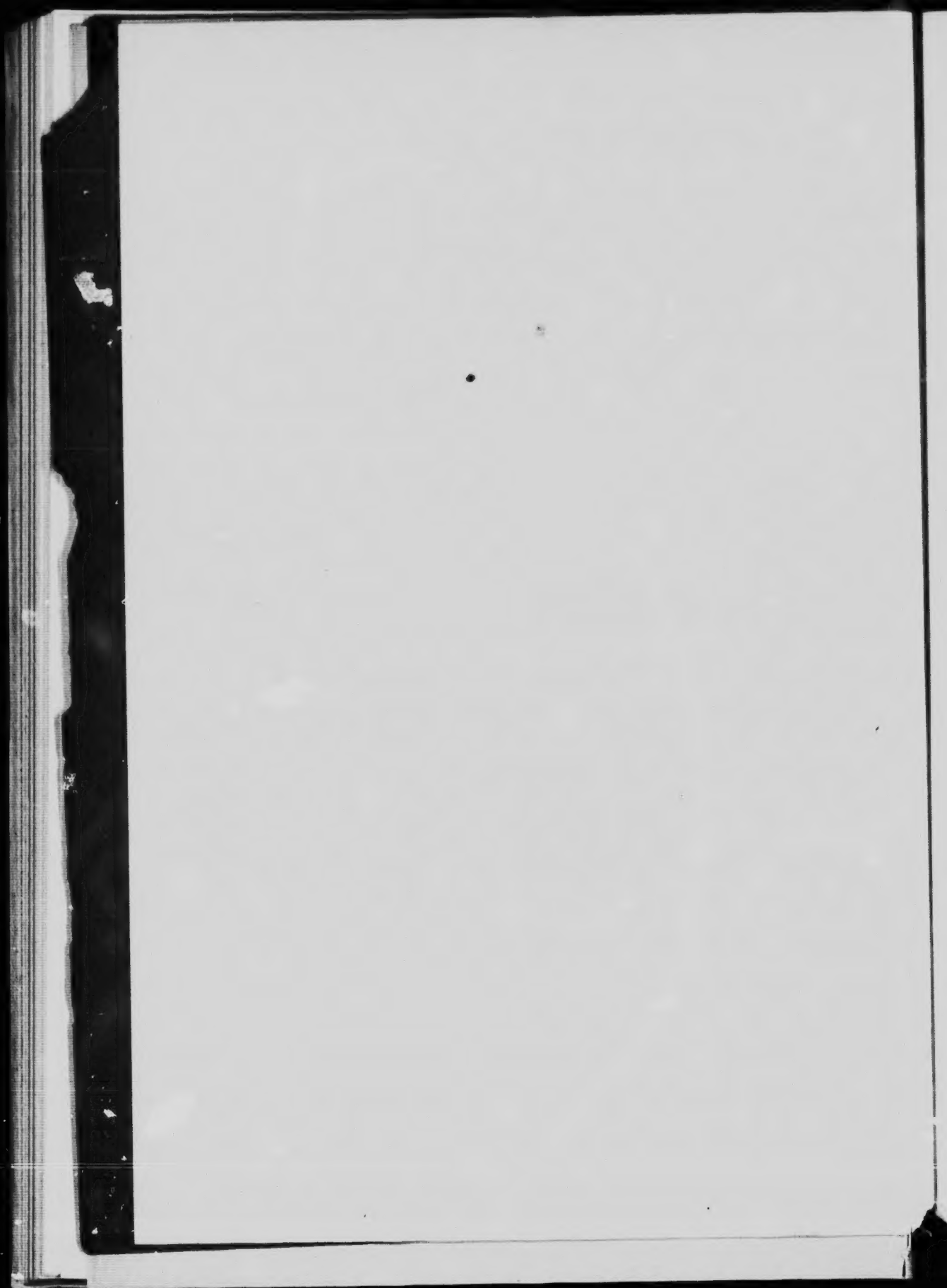
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Canadian Section.

Meeting held at Toronto, on Thursday, October 25, 1906

PROF. W. H. ELLIS IN THE CHAIR.

THE DETERIORATING EFFECT OF "ACID PICKLE" ON STEEL RODS, AND THEIR PARTIAL RESTORATION ON "BAKING."

BY HERBERT A. SMITH AND W. R. LANG.

It is the universal practice in wire manufacture to "pickle" the steel rods in order to remove the black scale of oxide before drawing them into wire. This has long been known to deteriorate the quality of the rods, but it has been found that, if the rods are "baked" at 250° F. for some hours after this treatment, they are in a great measure restored, and can then be drawn into wire. The following physical tests were made in order to find out quantitatively the amount of such deterioration and subsequent restoration of the rods. The work was done on samples taken in the different stages of the process of manufacture at the Imperial Steel and Wire Company's plant at Collingwood, Ontario, at the suggestion of the manager, Mr. J. A. Currie. Samples of three different coils of rods were taken in the following stages:— (1) Before treatment with acid; (2) after acid cleaning; (3) after rusting; (4) after lime coating; (5) after baking. Table I. shows the tensile strength, percentage elongation over 8 ins., and percentage contraction of the rods; the strength of the bath, time immersed, and time of baking are also given.

The tests were made with a Richlé machine, by the kind permission and with the assistance of the staff in the Engineering Department, University of Toronto. It may be observed that the ultimate strength remains throughout the process as constant as can be expected of that kind of test. The percentage elongation over 8 ins. rather unexpectedly remains constant, but the sudden drop in the ability to contract to a small "neck," before breaking, occurs immediately after acid treatment, and remains practically constant until after "baking," when a marked recovery in this property occurs, the three rods agreeing well in this behaviour. It is important to note that on this property of "necking in," or contracting in area on stretching, depends the property of drawing well through

TABLE I.

Rod	Strength in lb. per sq. in.			Elongation over 8 ins.			Percentage contraction.		
	A	B	C	A	B	C	A	B	C
Before treatment	65,700	59,700	60,100	per cent. 16	per cent. 12	per cent. 12	per cent. 63	per cent. 66	per cent. 67
After acid cleaning	61,400	59,700	64,200	16	12	13	38	44	44
" rusting	62,800	57,000	64,700	17	14	11	38	47	41
" lime coating	63,700	59,700	67,000	16	14	—	37	47	56
" baking	66,700	58,000	67,000	16	13	—	57	66	—

The strengths of acid used, at 100° C., were: A, 38 per cent.; B, 11 per cent.; and C, 10 per cent.; and the times of immersion in the baths: A, 1 hr.; B, 45 mins.; C, 1 hr. 10 mins. All the rods remained in the "baker" for about 4 hours.

the die, which is a conical hole in a block of tungsten steel.

This deterioration and recovery at the same stages in the process is also well shown in the following bending tests, which corroborate the contraction tests:—

TABLE II.
Bending tests on the rods.

	Before treatment.	After acid cleaning.	After rusting.	After lime coating.	After baking.
Rod A.	100	70	64	64	100
" B.	100	60	56	57	99
" C.	100	71	55	53	100

These figures are relative, of course, and express the ability to bend a certain number of times through a definite angle before breaking. They are the result of averaging eight or ten tests in each case. The highest number was taken as 100, and the rest calculated proportionately. The results show a break in the bending properties of the rod immediately after acid treatment, and a recovery after "baking," thus corresponding to the effect on the rods as indicated by the contraction tests.

Shearing tests were also made, but the differences were so small that no conclusions could be drawn from them.

An examination of the wires of different diameters drawn from these rods (correspondingly marked A, B, C) was also made in the same manner:—

TABLE III.
Tensile strength and percentage contraction of wires.

1. *Tensile strength.*

		Wires A.	Wires B.	Wires C.
	Diam. in.	lb. per sq. in.	lb. per sq. in.	lb. per sq. in.
(a)	0.175	72,900	93,700	93,700
(b)	0.142	112,600	113,900	113,900
(c)	0.112	117,300	122,400	122,400
(d)	0.091	—	138,400	131,000
(e)	0.072	137,000	150,000	150,000

2. *Percentage contraction.*

		per cent.	per cent.	per cent.
(a)	0.175	52.0	54	47
(b)	0.142	45.0	38	36
(c)	0.112	28.5	31	32
(d)	0.091	—	36	33
(e)	0.072	20.0	37	30

It will be observed that the tensile strength of the wires drawn through the sulphuric acid was not so high as that of the wires drawn through the nitric acid. This means that the wires drawn through the sulphuric acid would be necessary, which would stand no more drawing than the better wires. The only rod that was drawn through the sulphuric acid, while the rods drawn through the nitric acid were longer than usual—and as possible. The result was an unnecessary amount of drawing that only weaker acid could do.

Table IV. gives the results of the tests of the wires: this also was the better.

Bending

	Diam. in.	Wire
(a)	0.175	9
(b)	0.142	9
(c)	0.112	8
(d)	0.091	8
(e)	0.072	8

Many superintendents of the steel works have observed that the steel "cold short" is highly improbable, as the sulphur content is the same before and after treatment. It is suggested that a "hydride" of steel is suggested. Several tests have been obtained, but not published. The investigation

It is observed that wires B and C have a higher strength than wire A. Incidentally the increase of strength on drawing out will be observed. The reduction in cross-section percentage, as the diameter of the wire decreases, is not so great in B and C as in A. This means that these wires could probably be drawn through two more dies before annealing was necessary, while wire A would, in all likelihood, require more drawing. Thus B and C appear to be the better. The only difference in the treatment of the wires is that rod A was cleaned in 38 per cent. of acid, while rods B and C were cleaned in 10 per cent. They were all "baked" about four hours—longer than usual—and are probably restored as much as possible. The results indicate that strong acid causes a necessary amount of deterioration in the rod, and a weaker acid should be employed.

Table V. gives the comparative bending abilities of the wires. This also would indicate that wires B and C are

TABLE IV.

Bending tests on the wires.

	Wire A.	Wire B.	Wire C.
1 in.	91	100	100
5/8	90	97	100
1/2	89	100	83
3/8	—	100	80
1/4	86	100	94

Superintendents of plants have attributed the defect to the presence of sulphur, knowing that sulphur in steel "cold short." This appears to the authors to be probable, as careful analyses show no difference in sulphur content, which was 0.051 per cent. both before and after treatment. It seems much more probable that "iron sulphide" of iron is formed, as has often been found. Several tests confirmatory of this idea were made, but not sufficiently conclusive for present purposes. The investigation is being continued.

